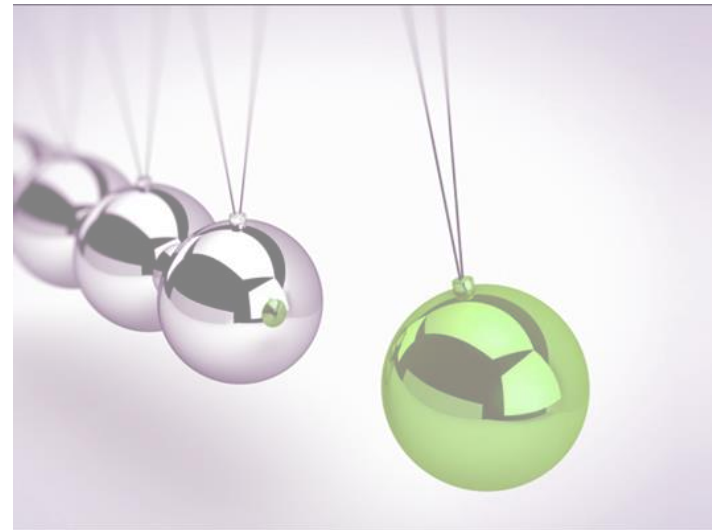


Mechanics

2015 EdExcel A Level Physics
Topic 2

**Projectile
Motion**



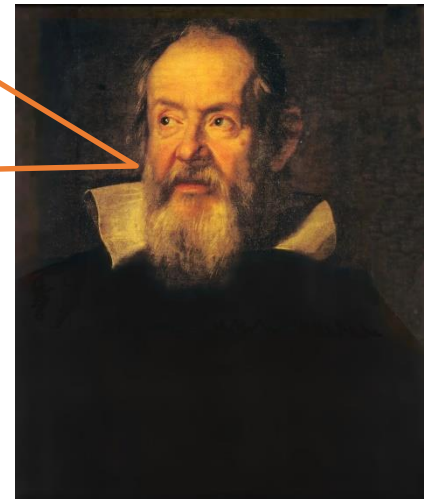
Projectile Motion



Projectile Motion

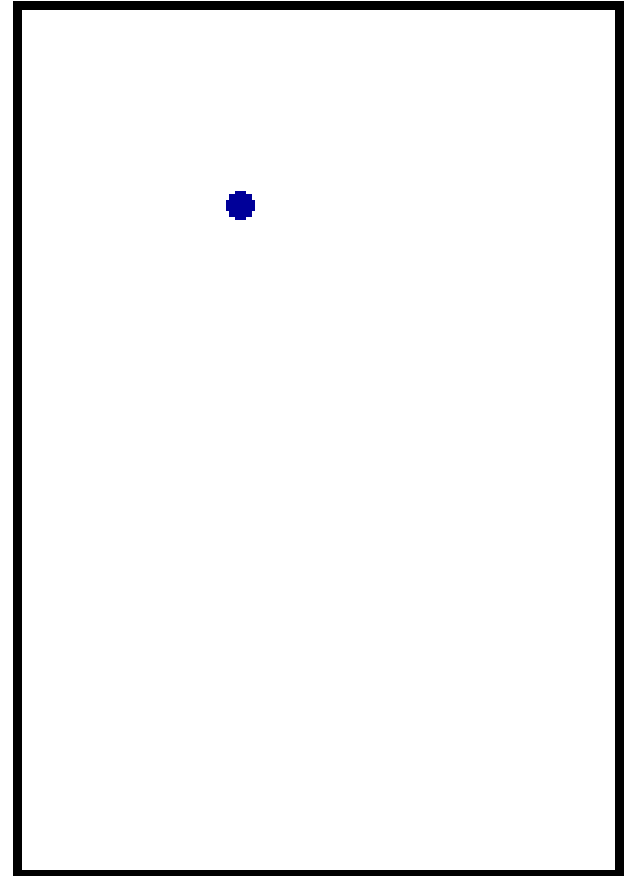
- We will consider the two-dimensional motion of an object
 - Vertical
 - Horizontal

A projectile is
An object on
which the only
force acting is
gravity



Types of Projectile Motion

- Horizontal
 - Motion of a ball rolling freely along a level surface
 - Horizontal velocity is *ALWAYS* constant
- Vertical
 - Motion of a freely falling object
 - Force due to gravity
 - Vertical component of velocity changes with time
- Parabolic
 - Path traced by an object accelerating only in the vertical direction while moving at constant horizontal velocity

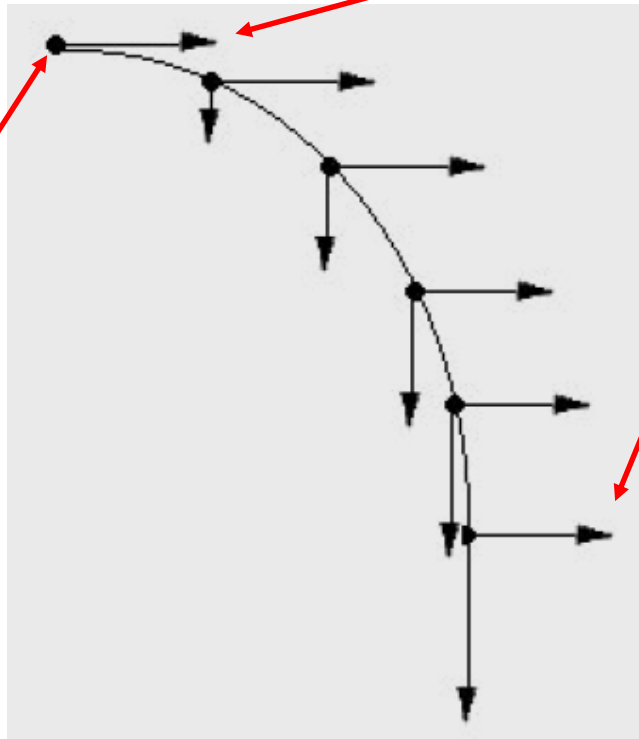


Horizontal Projectiles

Projectiles which have NO upward trajectory and NO initial VERTICAL velocity.

$$v_{ox} = v_x = \text{constant}$$

$$v_{oy} = 0 \text{ m/s}$$



Horizontal Projectiles

To analyze a projectile in 2 dimensions we need 2 equations. One for the “x” direction and one for the “y” direction. And for this we use kinematic #2.

$$x = v_{ox}t + \frac{1}{2}at^2$$

$$x = v_{ox}t$$

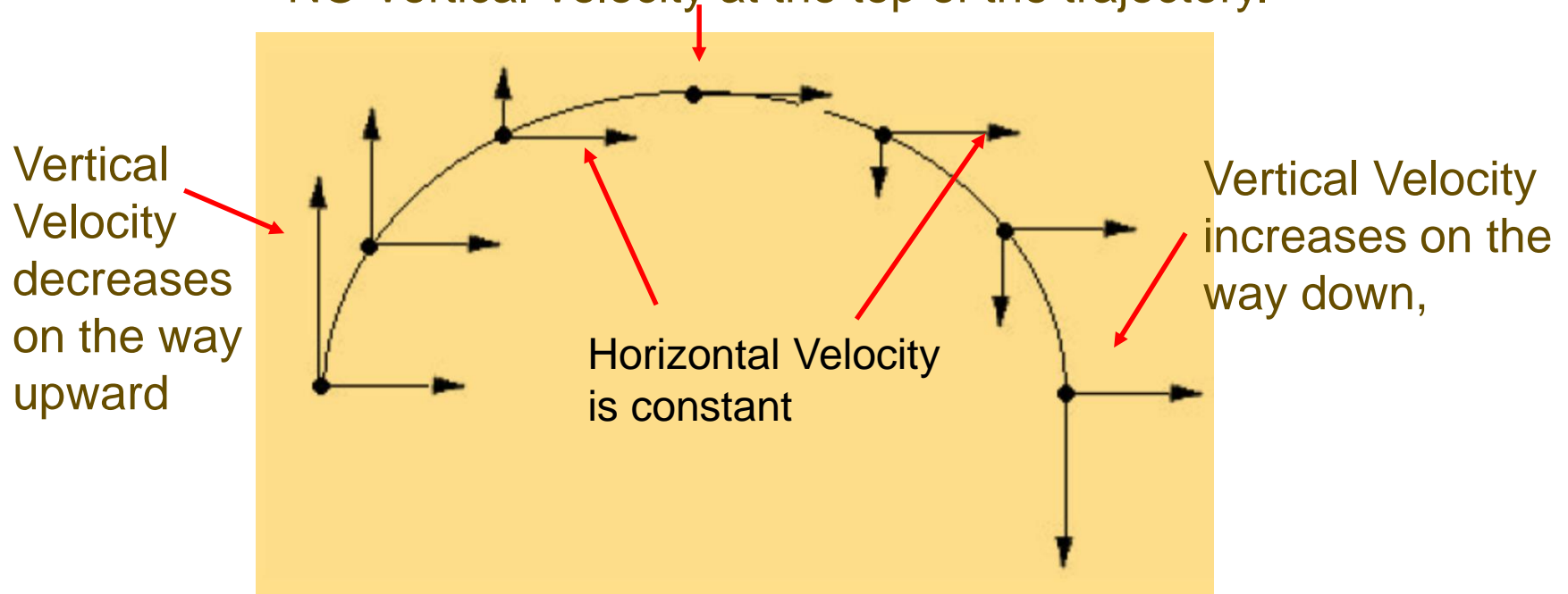
$$y = \frac{1}{2}gt^2$$

Remember, the velocity is **CONSTANT** horizontally, so that means the acceleration is **ZERO!**

Remember that since the projectile is launched horizontally, the **INITIAL VERTICAL VELOCITY** is equal to **ZERO**.

Vertical Projectiles

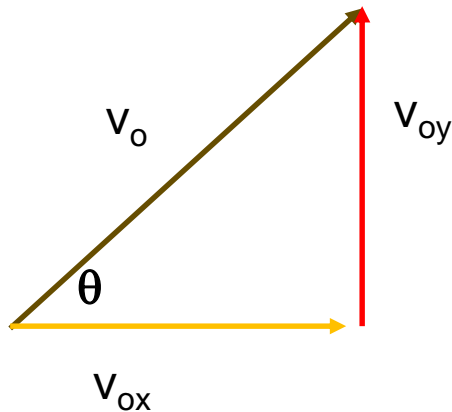
NO Vertical Velocity at the top of the trajectory.



Component of velocity	Magnitude of velocity	Direction of velocity
Horizontal	Constant	Constant
Vertical	Decreases up, 0 @ top, Increases down	Changes

Vertical Projectiles

If the projectile was launched at a angle, the velocity **MUST** be broken into components!!!

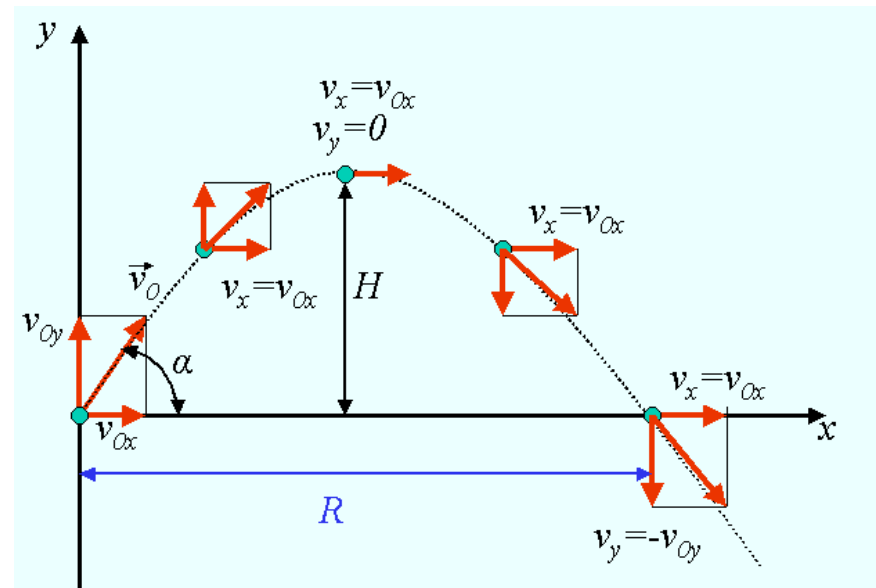


$$v_{ox} = v_o \cos \theta$$

$$v_{oy} = v_o \sin \theta$$

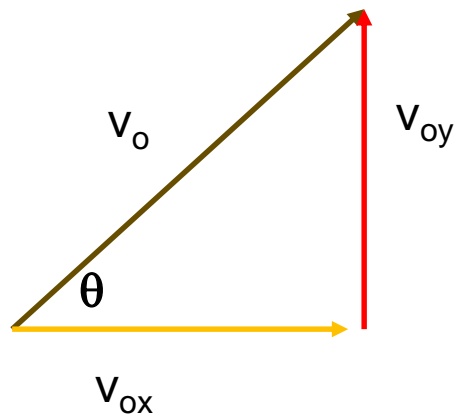
Vertical Projectiles

There are several things that must consider when doing these types of projectiles besides using components. If it begins and ends at ground level, the “y” displacement is ZERO: $y = 0$



Vertical Projectiles

You will still use kinematic #2, but YOU MUST use COMPONENTS in the equation.



$x = v_{ox} t$	$y = v_{oy} t + \frac{1}{2} g t^2$
----------------	------------------------------------

$$v_{ox} = v_o \cos \theta$$

$$v_{oy} = v_o \sin \theta$$

Equations

- X- Component

$$x_f = x_i + v_{xi}t$$

- Y- Component

$$y_f = y_i + v_{yi}t - \frac{1}{2}gt^2$$

$$v_{yf}^2 = v_{yi}^2 - 2g\Delta y$$

Note: $g = 9.81 \text{ ms}^{-2}$

$$v_{yf} = v_{yi} - gt$$

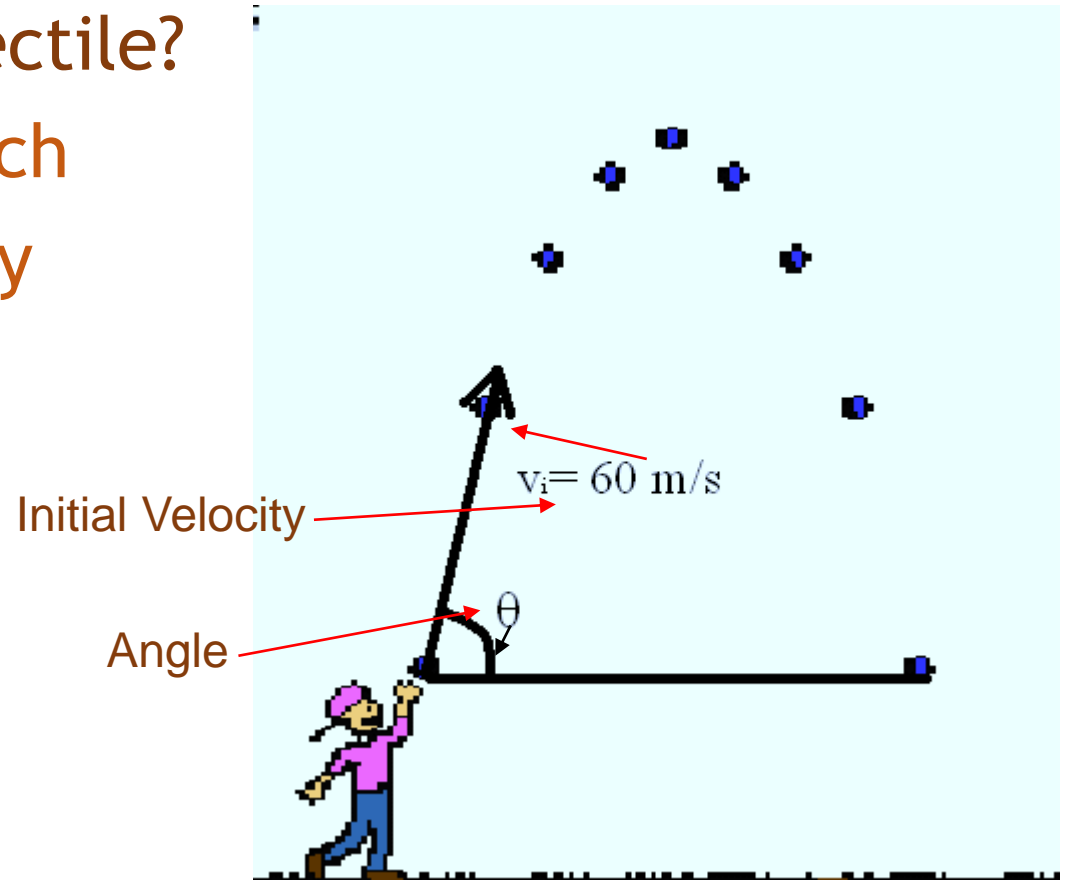
- Vectors

$$v_{xi} = v_i \cos(\theta)$$

$$v_{yi} = v_i \sin(\theta)$$

Factors Affecting Projectile Motion

- What two factors would affect the horizontal range of a projectile?
 - Angle of launch
 - Initial velocity



Practice Questions

- 1) How far will a cricket ball go if it is thrown upwards with an initial velocity of 10ms^{-1} ?
- 2) How far will a table tennis ball go if it is thrown upwards with an initial velocity of 5ms^{-1} ?
- 3) A human cannonball is projected vertically upwards and she reaches a vertical height of 20m before coming back down. How fast was she going when she left the cannon?
- 4) A test tube falls off the table. If the table is 1m high how fast was the test tube going when it hit the floor?

Longer question

An object is fired from the ground at 100 meters per second at an angle of 30 degrees with the horizontal

- Calculate the horizontal and vertical components of the initial velocity
- After 2.0 seconds, how far has the object traveled in the horizontal direction?
- How high is the object at this point?

Example questions

- 1) Lauren throws a bowling ball at Tom and it lands on his foot. If the ball started 1.2m above Tom's foot and the distance between them was 2m calculate both the time taken and the initial velocity of the ball.
- 2) Sam fires a gun and the bullet leaves the barrel at a speed of 200ms^{-1} . If it landed on the ground 500m away calculate how long the journey took and how high up Sam was holding the gun from ground level.
- 3) Fergus likes knocking test tubes off the table. If he hits one with an initial velocity of 2ms^{-1} and the table is 1m high calculate the time taken for the test tube to hit the floor and how far away from the table it landed.

Recap questions

- 1) Andrew Murray hits a tennis ball and it passes horizontally over the net and lands just inside the baseline of the court. The net has a height of 1.07m and is 11.9m from the baseline. Find the horizontal speed of the ball.
- 2) Aguero takes a free kick and it flies into the top corner horizontally. If the corner is 2.4m above the ground and the goal is 18m away calculate the time taken for the ball to reach the goal.